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# The effectiveness of the lentera learning model to improve pedagogical competence with the covariable of intensity of involvement in science learning in early childhood teacher education program

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## Abstract

The lack of pedagogical competence and involvement in early childhood teacher education programs in science learning is influenced by several factors. A monotonous learning model is one such factor that affects the learning process, making it less engaging and diminishing motivation. Therefore, a new learning model that incorporates research results as study material in lectures is necessary. Researchers have developed the Literacy and Research Exploration in Learning (LENTERA) learning model to address this issue. This study aims to evaluate the effectiveness of the LENTERA learning model in enhancing pedagogical competence, considering the intensity of involvement in science learning among students in early childhood teacher education programs. The research employed a quasi-experimental design with a single-factor independent group and covariates. The trial involved 64 students, and data collected included pedagogical competence and the level of involvement in science learning. Data collection was conducted using testing techniques, and the analysis involved descriptive statistics. Inferential statistical analysis, specifically covariance analysis, was used to test the hypothesis. The results indicate that the LENTERA learning model effectively improves pedagogical competence among early childhood teacher education students, with the intensity of involvement serving as a significant supporting factor.

**Keywords:** Early childhood teacher education, Intensity of student involvement, Lentera learning model, Pedagogical competence, Science learning.

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## 1. Introduction

Early childhood teacher education students must have the competence to implement a comprehensive learning approach, design activities that are appropriate to children's cognitive, social, emotional, and motor development, and carry out holistic assessments of student development [1, 2]. In this context, student involvement during the learning process becomes a crucial factor to ensure mastery of these skills. Through active involvement, students can better understand theoretical concepts, practice practical skills, and develop creativity and innovation in designing learning activities that are appropriate for early childhood [3, 4]. High levels of engagement can also increase students' motivation to learn, so that they are better prepared to face real challenges in the field, including implementing learning methods that support children's holistic development. Thus, learning that encourages active student involvement not only strengthens their pedagogical competence but also supports the achievement of quality early childhood teacher education students [5, 6].

Although the pedagogical competence of early childhood teachers has a central role in providing stimulation and learning experiences that are appropriate to children's developmental needs, many early childhood teachers in the field still face difficulties in implementing interactive, creative, and enjoyable learning methods [7, 8]. Many teachers face difficulties in implementing innovative and interactive learning methods, which results in low student engagement in the learning process. This fact is also supported by research results that reveal that the TPACK (Technological Pedagogical Content Knowledge) competency of prospective teachers is not optimal; this means that prospective teachers have not fully mastered the integration of technology, pedagogy, and content in their teaching [9, 10].

The learning process of science courses for early childhood needs to be strengthened because it has a strategic role in forming pedagogical competence and increasing the involvement of early childhood teacher education students [5, 11]. Science learning that includes product, process, and attitude components plays an important role in building a comprehensive understanding of scientific concepts, critical thinking skills, and scientific values that are relevant to everyday life. For early childhood teacher education students, this understanding is crucial to teaching science to early childhood effectively. By integrating products (science knowledge), processes (scientific methods), and attitudes (curiosity and positive values towards science), students can develop a holistic and enjoyable learning approach [12, 13]. Therefore, developing student involvement and pedagogical competence is essential to ensure that they are able to design and implement science learning that is appropriate to the characteristics of early childhood, thereby improving the quality of education and children's learning experiences [3, 14].

In general, the observation results show that the pedagogical competence of early childhood teacher education students in various aspects of learning still needs to be improved. Although some aspects, such as classroom management and providing feedback, show better results, many other areas, such as the application of learning methods, assessment, and use of technology, still need improvement. The average score obtained indicates that they require more training and support to enhance skills in designing learning media, evaluation, communication, and the use of technology in learning. Additionally, the observation results reveal that student engagement in learning needs to be improved. While aspects of emotional engagement, such as interest and satisfaction in learning, are relatively good, other engagement dimensions, including proactivity, participation, understanding of the material, and problem-solving, still show low results. This highlights the necessity for improvement across various engagement dimensions to support a more effective learning process.

The lack of pedagogical competence and involvement of early childhood teacher study programs in science learning is also caused by a number of factors. Among others, the limited infrastructure (sarpras), such as incomplete science laboratories or minimally adequate practical facilities. In addition, the curriculum is less relevant and too theoretical, as well as the lack of integration of practical work or field experience can also hinder student interest and involvement [5, 15]. The monotonous learning model makes the learning process less interesting and reduces learning motivation. The use of less relevant learning media and teaching materials that do not match the needs of students can also make science learning less effective. Therefore, efforts are needed to improve the quality of infrastructure, revise the curriculum to be more relevant, implement interactive and innovative learning models, and utilize adequate learning media [16, 17]. In addition, the role of lecturers in choosing learning models that suit students' needs and in compiling teaching materials that support science learning is also very important to increase student involvement in science learning.

The solution chosen to overcome this problem is to develop a learning model that explores research results as study material in lectures. In the learning model developed, students do not directly conduct research but use research results as additional material in lectures to improve pedagogical competence and student involvement [18, 19]. Through this model, students are accustomed to analyzing, evaluating, and understanding the context and results of relevant research that has been conducted previously, thus strengthening students' ability to apply the concepts learned in practical situations. This model encourages students to be more actively involved in the learning process because they are trained to think critically and be open to various perspectives expressed in current research. Thus, this model not only builds more solid pedagogical competence but also increases students' enthusiasm and involvement in lectures, creating more meaningful and relevant learning experiences [20, 21].

In line with the explanation, this study developed a learning model called the Literacy and Research Exploration in Learning (LENTERA) learning model. The LENTERA learning model is closely related to the development of pedagogical competence and increasing the involvement of early childhood teacher education students. This model is designed based on a research-based learning approach that places students at the center of the learning process. With steps such as problem identification, theory introduction, hypothesis formulation, hypothesis testing, data analysis, and reporting results, students are invited to actively think critically, analyze, and solve problems independently and collaboratively. In addition, student involvement increases because they are empowered to explore new ideas and see the relevance of learning to real practices

in the field. Thus, the LENTERA model not only strengthens the understanding of pedagogical concepts but also motivates students to be more emotionally and intellectually involved in the learning process.

In contrast to previously developed learning models such as project-based learning or contextual learning, which primarily emphasize practical skills or basic teaching competencies, the LENTERA model offers a more comprehensive approach by integrating research-based learning into the development of pedagogical competence for early childhood teacher education students. Earlier studies often separated theoretical understanding from practical application, resulting in limited emotional and intellectual engagement from students during the learning process. The novelty of this study lies in the design of the LENTERA model, which positions students not only as active participants but also as researchers who systematically engage in stages such as problem identification, theory introduction, hypothesis formulation and testing, data analysis, and reporting. This innovative approach encourages students to think critically and reflectively, while also connecting their academic learning to real-world practices in the field an approach that remains relatively uncommon in the context of early childhood teacher education.

This study aims to analyze the effectiveness of the Lentera learning model in improving pedagogical competence, considering the covariate of involvement intensity in science learning among early childhood teacher education students. With a higher involvement intensity in learning, it is expected that students will be able to apply research findings in planning and implementing creative, effective, and enjoyable learning experiences. This approach supports the holistic development of their pedagogical abilities. The LENTERA model offers significant potential for creating prospective early childhood teachers who are competent in designing and managing evidence-based learning.

## 2. Method

This study uses a quasi-experimental method with a single-factor independent group design using covariates [22]. This study uses a single-factor independent group design with the use of covariates, which is a type of quasi-experimental research. The research procedure is divided into three stages: the initial stage (pre-experiment), the research implementation stage, and the final stage of the research. The research design and variable constellation are presented in Table 1.

**Table 1.**
Research Design.

| **Learning Approach (A)** | | | |
|---|---|---|---|
| **Lantern learning model ($A_1$)** | | **Conventional ($A_2$)** | |
| X | Y | X | Y |

**Note:** Information:
A1: Treatment factor (Contextual Learning Model based on Controversial Issues).
A2: Control Factor (Conventional Learning).
X: Intensity of involvement in science learning.
Y: Pedagogical competence.

In this study, the population is defined as the number or unity of individuals who have the same characteristics, and the generalization of the study is applied to this unity. The subjects in this study were bachelor's degree students in early childhood teacher education, who are the target group undergoing the education process to become teachers at the early childhood education level. Sampling in this study used random sampling techniques. The test subjects in this study consisted of 64 students.

The data collected in the study include pedagogical competency data and student engagement data. To obtain each data, the instrument distribution is used. The technique used in data collection is the test technique. The pedagogical competency test is used to collect data on student teaching skills. The student engagement test is used to obtain data on the results of student engagement in science learning. The instrument grid is shown in Table 2 and Table 3.

**Table 2.**
Student Pedagogical Competency Test Grid.

| Variables | Aspect | Indicator |
|---|---|---|
| Pedagogical Competence | Understanding the Curriculum and the Teaching and Learning Process | Students are able to identify the objectives and basic science competencies that are relevant in the early childhood teacher education program curriculum. |
| | | Students understand the stages of child development and their implications for science teaching strategies. |
| | | Students are able to plan science learning that aligns with the early childhood teacher education program curriculum, using an appropriate approach for early childhood. |
| | | Students understand how to integrate science concepts into themes that are relevant to the early childhood teacher education program curriculum. |
| | Professional Knowledge of Science Teaching Methods | Students understand the appropriate methods and techniques for teaching basic science concepts to young children. |
| | | Students can explain inquiry approaches and simple experiments that are relevant to young children. |
| | | Students demonstrate the ability to design interactive science learning media that are appropriate to the characteristics of young children. |
| | | Students are able to explain basic science concepts in a simple and engaging way for young children. |
| | Ability to Manage Classroom and Implement Active Learning | Students can design active learning strategies that encourage active student involvement in class activities. |
| | | Students are able to manage class dynamics by supporting research-based learning processes, such as group work. |
| | | Students demonstrate the ability to use the LENTERA learning model to design and manage interactive class activities. |

**Table 3.**
Student Involvement Grid.

| Aspect | Indicator |
|---|---|
| Agentic engagement | Students actively provide suggestions or ideas in the learning process. |
| | Students show initiative to be more involved in learning activities. |
| | Students ask questions or provide input to improve the effectiveness of learning in class. |
| Behavioral Engagement | Students attend class regularly and on time. |
| | Students follow lecturers' instructions consistently and participate in all learning activities. |
| | Students are active in class discussions, presentations, and group activities. |
| Emotional Engagement | Students show interest and enthusiasm for the material being taught. |
| | Students feel satisfied and happy when involved in learning activities. |
| | Students show positive feelings about the learning process and interactions with classmates. |
| Cognitive Engagement | Students demonstrate critical and reflective thinking skills towards the content being studied. |
| | Students are able to connect concepts being studied with existing knowledge. |
| | Students demonstrate a willingness to seek additional information or other references to enrich their understanding. |

The data analysis used in this study is a descriptive analysis that includes all data obtained, and the tests describe the mean (M), standard deviation (SD), mode (Mo), and median (Me) of each variable studied. Before conducting the hypothesis test, prerequisite tests are performed, including a data distribution normality test, a variance homogeneity test between groups, a regression linearity test, a regression direction significance test, a regression line parallelism test, and a multicollinearity test. Inferential statistical analysis techniques are applied in hypothesis testing to evaluate the hypotheses in this study using covariance analysis.

## 3. Results and Discussion

### *3.1. Result*

#### *3.1.1. Descriptive Analysis*

In this study, the data collected were divided into three types: critical thinking skills data, civics learning outcomes data, and social skills data. The depiction of data for each group was carried out using central measurements, which included the average (mean), median, mode, standard deviation, variance, minimum data, maximum data, range, total data value, and number of subjects.

In summary, the results of the calculation of pedagogical competence scores and the intensity of involvement are shown in Table 4.

**Table 4.**
Recapitulation of Pedagogical Competency Score Calculation Results and Intensity of Involvement.

| No. | Data | A1X | A1Y | A2X | A2Y |
|---|---|---|---|---|---|
| 1 | Average | 160.68 | 134.00 | 138.92 | 128.06 |
| 2 | Median | 161 | 133 | 138,50 | 128 |
| 3 | Mode | 160 | 143 | 135 | 122 |
| 4 | Standard deviation | 5.55 | 7.74 | 7.44 | 6.07 |
| 5 | Variance | 30.83 | 60,00 | 55,45 | 36.85 |
| 6 | Span | 20 | 26 | 27 | 24 |
| 7 | Minimum | 150 | 120 | 125 | 116 |
| 8 | Maximum | 170 | 146 | 152 | 140 |
| 9 | Amount | 4981 | 4154 | 5001 | 4610 |

Based on Table 4, the results of the analysis show that there is a significant difference between the experimental group and the control group in terms of pedagogical competence scores and the intensity of involvement. The average pedagogical competence score in the experimental group was 160.68, which was higher than the control group, which had an average score of 138.92. This indicates that the use of the Lentera Learning Model has a positive impact on improving students' pedagogical competence. Similarly, the intensity of student involvement in science learning in the experimental group showed a higher average, namely 134, compared to the control group, which only achieved an average of 128.06.

The lower variation in scores in the experimental group compared to the control group, as seen from the smaller standard deviation values (5.55 for pedagogical competence and 7.74 for intensity of involvement), indicates that learning with the Lentera model not only increases the average score but also provides more consistent results among students. The smaller range of scores in the experimental group also indicates that this learning model is effective for various levels of student ability, thus reducing the achievement gap within the group.

*3.1.2. Requirements Analysis Testing*

Before testing the hypothesis using ANCOVA, analysis requirements tests were first carried out, including: (1) testing the normality of data distribution, (2) testing the homogeneity of variances, and (3) testing the linearity and significance of regression between the covariate and the dependent variable.

*3.1.3. Normality Test*

The normality test of data distribution aims to determine whether the sample originates from a normally distributed population. In this study, the normality test utilizes SPSS 16 for Windows, which employs the Kolmogorov-Smirnov test. The results of the normality test, conducted with SPSS 18 for Windows, also using the Kolmogorov-Smirnov test, are presented in Table 5.

**Table 5.**
Normality Test Results.

| Sample Group | Information | Number of Samples | Significant level | Kolmogorov Smirnov | Conclusion |
|---|---|---|---|---|---|
| 1Y | Pedagogical Competence (Experiment) | 31 | 0.05 | 0.200 | Normal |
| 2Y | Pedagogical Competence (Conventional) | 36 | 0.05 | 0.135 | Normal |
| A1X1 | Intensity of Engagement (Experiment) | 33 | 0.05 | 0.160 | Normal |
| 2X1 | Learning outcomes (Conventional) | 36 | 0.05 | 0.060 | Normal |

Based on Table 5 shows that the significance level of the Kolmogorov-Smirnov normality test on the six data groups is greater than the specified data significance level. Therefore, H0 is accepted and H1 is rejected. So, all groups have data that are normally distributed.

*3.1.4. Homogeneity of Variance Test*

The homogeneity of variance test is used to determine whether the variances of the groups to be compared are homogeneous, or in other words, to assess whether the groups are suitable for comparison. In this study, the homogeneity of variance test was conducted using SPSS 16 for Windows, which employs Levene's test for equality of error variances. The results of the analysis are shown in Table 6.

**Table 6.**
Test of Homogeneity of Variances Using Levene's Test of Equality of Error Variances.

| F | df1 | df2 | Sig |
|---|---|---|---|
| 0.237 | 1 | 66 | 0.628 |

Table 6 shows that the level of significance of Levene's test for the equality of error variances in the learning presentation data group is greater than the specified level of significance, namely 0.628 > 0.05. Therefore, H0 is accepted and H1 is rejected. So, all data groups have homogeneous variances.

*3.1.5. Linearity Test*

The linearity test serves to demonstrate whether the relationship between the criteria and covariates is linear. The test was conducted using SPSS 16 for Windows, which assesses the significance of the F deviation from linearity in the pedagogical competence data group, connected to the intensity of involvement data in learning. The results of the analysis are shown in Table 7.

**Table 7.**
The Relationship between Pedagogical Competence and Intensity of Involvement in Learning.

| | | | Sum of Squares | df | RJK | F | Sig |
|---|---|---|---|---|---|---|---|
| Overall Learning Achievement *Overall Multicultural Attitude | Between the groups | Join | 4726.075 | 38 | 262.56 | 2.089 | 0.034 |
| | | Lineartity | 3016.375 | 1 | 3016.375 | 23.999 | 0 |
| | | Save from linearity | 1709.7 | 37 | 100.571 | 0.8 | 0.681 |
| | In Group | | 4021.964 | 30 | 125.686 | | |
| | Total | | 8748.039 | 67 | | | |

Based on Table 7, it is known that the significance of F deviation from linearity has a value of >, namely 0.681, so the significance of F deviation from linearity is > the specified significance, namely 0.681 > 0.05. It can be concluded that the level of linearity between pedagogical competence and the intensity of involvement in learning as a covariate is stated as linear.

*3.1.6. Hypothesis Testing*

After the ANCOVA test requirements are met, the hypothesis test calculation can be carried out. The difference in pedagogical competence between students who follow the Lentera learning model based on the intensity of involvement in learning and students who follow conventional learning is tested using ANCOVA assisted by SPSS 16 for Windows. This hypothesis will be accepted if the significance value of F in the inter-subject effect test is smaller than the specified significance level (significance F < 0.05). The results of the calculation are shown in Table 8.

**Table 8.**
Hypothesis Test Results with ANCOVA.

| Source variation | Sum of squares | df | RJK | F | Sig |
|---|---|---|---|---|---|
| Model Corrected | 2154.326 | 3 | 718.109 | 18.453 | < 0.001 |
| Intercept | 5256.874 | 1 | 5256.874 | 135.022 | < 0.001 |
| Group | 512.675 | 1 | 512.675 | 13.158 | < 0.001 |
| Error | 1426.851 | 1 | 1426.851 | 36.615 | < 0.001 |
| Total | 214.800 | 1 | 214.800 | 5.508 | < 0.05 |
| Total Correction | 2498.525 | 66 | 37.856 | | |

**Note:** a. R square = 0,93 (R Adjusted square = 0,74).

The results of the ANCOVA test in Table 8 the analysis demonstrates that the Lentera learning model has a significant influence on enhancing the pedagogical competence of PGPAUD students after controlling for the variable of involvement intensity (F = 5.508, p < 0.05). Additionally, the covariate of involvement intensity significantly contributes to pedagogical competence, with an F value of 13.158 (p < 0.001). Similarly, the covariate of pedagogical competence shows a highly significant effect, with an F value of 36.615 (p < 0.001). The overall contribution of the model to pedagogical competence, indicated by the corrected model value (F = 18.453, p < 0.001), suggests that the Lentera learning model effectively improves students' pedagogical competence by considering the involvement intensity during the learning process. Then the results of the termination coefficient are shown in Table 9.

**Table 9.**
Covariable Correlation Coefficient on Pedagogical Competence.

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | F Change | Sig. F Change |
|---|---|---|---|---|---|---|
| Pedagogical Competence and Intensity of Involvement | 0.652 | 0.426 | 0.405 | 6.154 | 21.453 | < 0.001 |

The results of the analysis in Table 9 show that there is a significant relationship between the intensity of involvement and learning groups on pedagogical competence, with a correlation coefficient (R) value of 0.652. This indicates a fairly strong relationship between these variables. The coefficient of determination ($R^2$) of 0.426 suggests that 42.6% of the variation in pedagogical competence can be explained by the intensity of involvement and learning groups. Meanwhile, the remaining 57.4% is influenced by other factors outside this research model. The F Change value of 21.453 with a significance (Sig. F Change) of less than 0.001 confirms that the contribution of independent variables to pedagogical competence is simultaneously significant.

Thus, it can be concluded that the intensity of involvement and learning models play an important role in improving students' pedagogical competence.

## 4. Discussion

The results of this study indicate that the Lentera Learning model is effective in improving the pedagogical competence of early childhood teacher education students, with the intensity of involvement in science learning as a covariable. Lentera Learning is designed to provide a student-centered learning experience, which not only motivates them to be more actively involved but also provides space for the development of critical, analytical, and reflective thinking skills [23-25]. Based on the results of the analysis, there is a significant difference between the experimental and control groups in terms of pedagogical competence. The experimental group that followed the Lentera Learning Model had a higher average score compared to the control group that used conventional learning methods. This supports previous findings stating that innovative learning involving active interaction and deep reflection can improve students' pedagogical competence [26, 27].

Lentera Learning creates a learning environment that supports the exploration of science concepts through a contextual and collaborative approach. This approach allows students to relate theory to practice, understand the application of pedagogy in various contexts, and develop teaching strategies that are relevant to students' needs [28, 29]. The results of the study also showed that the intensity of student involvement in science learning contributed significantly to improving pedagogical competence. Students who were more actively involved in discussions, experiments, and reflections demonstrated a better understanding of pedagogical concepts compared to students with low involvement. This finding aligns with previous studies, which state that active involvement in the learning process is one of the key factors in developing pedagogical competence [30, 31].

Active involvement allows students to hone their skills in identifying problems, designing solutions, and evaluating learning outcomes. In the LENTERA learning model, students are engaged in various collaborative activities that require them to work together, discuss, and solve problems independently or in groups [19, 32]. These activities not only enhance their cognitive understanding but also build self-confidence and social skills relevant to their profession as educators. The findings of this study reinforce and extend constructivist learning theories, which emphasize that knowledge is constructed actively through social interaction and meaningful engagement with real-world problems. Moreover, the results align with Vygotsky's sociocultural theory, which highlights the importance of social collaboration and scaffolding in the development of higher-order thinking skills. By positioning students as researchers in their own learning process, the LENTERA model operationalizes these theoretical foundations and demonstrates their practical impact on improving pedagogical competence. This research thus not only supports existing theories but also provides empirical evidence of how research-based, collaborative learning can be effectively implemented in teacher education to foster both intellectual and professional growth.

The implication of this finding is that the Lentera Learning Model can be used as an alternative approach to improve the quality of teacher education, especially in terms of pedagogical competence. This model provides a framework that allows students to learn actively, reflectively, and contextually, which is highly relevant to the needs of 21st-century education. By implementing the Lentera Learning Model, it is expected that students will not only understand pedagogical theory but also be able to apply it effectively in real learning situations. Additionally, it is important for lecturers to continue increasing the intensity of student involvement in learning. This can be achieved through engaging learning designs, the use of technology, and problem-based or project-based approaches. Thus, students will be more motivated to learn and develop the pedagogical competence necessary to support their success in the workforce.

Although this study shows positive results, there are several limitations that need to be considered. First, this study was only conducted on PGPAUD students at one institution, so generalizing the results to a wider population needs to be done with caution. Second, this study used a quasi-experimental method, so the possibility of other factors influencing the results cannot be completely eliminated. Further research is recommended to involve larger and more diverse samples and to use a stronger research design, such as a randomized controlled experiment. In addition, research can also explore other aspects, such as the effect of the Lentera Learning Model on students' communication skills or creativity, to provide a more comprehensive picture of the effectiveness of this mode.

## 5. Conclusion

This study shows that the Lentera Learning Model is effective in improving the pedagogical competence of early childhood teacher education students, with the intensity of involvement as a significant factor supporting the results. This active, contextual, and collaborative learning approach not only improves cognitive understanding but also students' social skills, making it a relevant method for 21st-century education. Despite the limitations in the scope of the study, these findings provide a strong basis for further development and application of this model in a broader context.

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